GEOLOGY AND PALEONTOLOGY.

A Batrachian Armadillo.—The significance of certain fragments which I observed several years ago in Permian material from Texas, has been established by a more complete specimen which I have received from the same locality. This consists of a portion of the skeleton, which includes ten consecutive vertebrae and their appendages, of the rhachitomous type, similar in general to those of Trimerorhachis. The genus differs from Trimerorhachis in this important respect. The neural spines are elevated, and the apex of each sends a stransverse branch which extends in an arch on each side to the ribs. These spinuous branches touch each other, forming a carapace. Above and corresponding to each of them is a similar dermal osseous element, which extends from side to side without interruption on the median line, forming a dermal layer of transverse bands which correspond to the skeletal carapace beneath it. To this remarkable genus I propose to give the name of Dissorophus. It is a veritable batrachian armadillo.

As to species characters, it is to be remarked that the intercentra are longer in proportion to their width than in the *Trimerorhachis insignis.* The heads of the ribs have a small free truncate angle below their capitulum. The extremities of the spinous roof-processes are free from each other for a short distance, and each has a depressed rounded sharp edge. The dermal bands above them terminate a little proximad of them and in a similar manner, and their extremities are closely appressed to the surface of the band below them, with which they slightly alternate. Their surface is very coarsely rugous, with ridges and fossae, whose long axes agree with those of the segments. This species I propose to call *Dissorophus multicinctus.* Length of ten vertebrae in place 93 mm.; width of intercentrum 16; length of do 9; elevation to roof 30; thickness of carapace 8; width of a carapacial band 9; length of do on curve 75. The species appeared to have been about the size of the Japanese salamander *Megalobatrachus maximus.*

The genus Dissorophus adds another to the remarkable forms already known from the American Permian. It is remotely approached by the genus Zatachys Cope, where a dermosseous scute is coössified with the apex of the neural spine.—E. D. Cope.

Cope on the Temporal Part of the Skull, and on the systematic position of the Mosasauridæ—A reply.—In the September Number of this Journal Prof. Cope has published a review

of two of my papers (Bemerkungen über die Osteologie der Schläfengegend der höheren Wirbelthiere Anat. Anz. x, 1894, pp. 315–330 and: On the Morphology of the Skull in the Mosasauridæ, Journ. Morphol. VII, 1892, pp. 1–22, pl. I–II), to which I should like to make some remarks.

1. *The Paroccipital.*

The bones of the temporal region in question I have termed squamosal, prosquamosal and quadratojugal. Cope states that I adopted the name prosquamosal (Owen, 1860), because the name supratemporal was used previously for a different element peculiar to the Teleostomous fishes. But this was not the only reason; the principal reason was, that with the name supratemporal, totally different elements were designated in the Stegocephalia and Ichthyosauria and in the Lacertilia (Anat. Anz. x, 1894, p. 320.)

Cope has called the three bones, the paroccipital, supratemporal and zygomatic, "after earlier authors" as he says. But the paroccipital is not the squamosal, the name supratemporal is misleading as stated before; and the name zygomatic has been used since the beginning of Anatomy, for the jugal or malar; how can Prof. Cope use this name for the quadrato-jugal? I thought I had shown once for all, that the opinion held by Prof. Cope, that the squamosal of the Squamata is homologuous to the paroccipital (opisthotic) is wrong. But it seems, that he is not convinced. He is, however, the only one among all living morphologists who has this opinion.

He believes that the exoccipital together with the paroccipital process in the Reptilia in which there is no free paroccipital (Ichthyosauria, Testudinata) represents the exoccipital alone. He states that nobody has ever found the paroccipital process as a separate ossification. But he is wrong about this: The free paroccipital, uniting later with the exoccipital and forming the paroccipital process has been first described, as far back as 1839, by Rathke[1]; in *Tropidonotus natrix* and this passage has been translated by Huxley in his well known Croonian lecture on the Theory of the Vertebrate Skull, delivered the 18st of November, 1858 before the Royal Society. It was also described by Leydig[2] in *Anguis fragilis*, in 1872.

[1] Rathke, Heinrich Entwicklungsgeschichte der Natter. Königsberg, 1839, pp. 201-202.

[2] Leydig Franz. Die in Deutschland lebenden Arten der Saurier. Tübingen, 1872, p. 26.

The paroccipital has been described in *Sphenodon* by me in 1889[3] in the following words. "In the old animal supraoccipital, exoccipitals, paroccipital, petrosals are united, but on the young all these elements are free. There is much cartilage between the supraoccipital and the petrosal and paroccipital. The paroccipital is united to the exoccipital by suture, the elements in question of a young *Sphenodon* resemble those in Chelone and especially in Ichthyosaurus." I may state here, that in a skull of *Sphenodon*, of 50 mm. in length from anterior end of premaxillary to occipital condyle, the suture between exoccipital and paroccipital is quite distinct, and also the characteristic Y-shaped sutures between the paroccipital, supraoccipital and petrosal.

Siebenrock[4] has independently, not knowing my paper in the Journal of Morphology, found out the same in *Sphenodon* and has given very good figures of the conditions. He has also shown in an absolutely convincing way,[5] that in the Lacertilia the paroccipital process is also homologuous to the paroccipital, and has given excellent figures demonstrating it. These two papers were mentioned by me in the paper published in the Anatomischer Anzeiger, discussed by Prof. Cope, but he certainly did not consult the papers, which are easily accessible.

After this demonstration of the free nature of the paroccipital in *Sphenodon* I think Prof. Cope will have to give up his view on the homology of the paroccipital of the Testudinata with the squamosal of the Lacertilia. I do not understand, how Prof. Cope could fall into such a fundamental error. We know since Hallman and it has since been redemonstrated dozens of times, that in the Reptilia and Birds, the semicircular canals of the ear are placed into 3 bones: 1, the petrosal; 2, the supraoccipital and 3, the paroccipital. These 3 bones come together and form that exceedingly characteristic Y-shaped suture, first mentioned by Hallman, and fully discussed by Huxley in his lectures on the Elements of Comparative Anatomy, London, 1864.

He already stated in his Croonian Lecture: "when the petrosal, mastoid (paroccipital) and squamosal are determined in the turtle, they

[3] Baur, G. On the Morphology of the Vertebrate Skull. Journ. Morph., III, 1889, pp. 467–468.

[4] Siebenrock, Friedrich. Zur Osteologie des Hatteria-Kopfes. Sizungsberichte d. Kais. Akad. Wiss. Wien. Mathem. naturw. Cl. Bd. CII, Abth. I, Juni, 1893, pp. 7–10. Pl. fig. 3. 5.

[5] Siebenrock, Friedrich; Das Skelet der *Lacerta simonyi* Steind., und der Lacertiden familie überhaupt; Sizungsb. d. Kais. Akad. Wiss. Wien. Mathem. naturw. Cl. Bd. CIII, Abth. I. April, 1894, pp. 4–9, Fig. Pl. III.

are determined in all the Reptilia. But the Crocodilia, Lacertilia Ophidia, differ from the turtle and Chelonia generally, in that their mastoid (paroccipital) is, as in the bird, anchylosed with the exoccipital." The matter is so simple and clear, that it can be demonstrated to any student who begins his work in Osteology.

Prof. Cope also states, that he has been hitherto alone in the opinion that the suspensorium of the quadrate of the Ophidia is the squamosum of the Lacertilia, but he forgets that this opinion was held already by Spix[6] in 1815. who has given excellent figures of these conditions in Lizards and Snakes; by Hallmann, Troschel, Gegenbaur and many others before 1870, when Cope read his paper.

Prof. Cope believes that the squamosal (his paroccipital) in the squamate can not be homologous with the squamosal in the Ichthyosauria, Colylosauria and Stegecephalia, with which it is identified by me, since it is a brain-case bone, while the latter is a temporal roof-bone, a fundamental difference, as he says. I never knew that the squamosal (paroccipital, Cope) of the Squamata is a brain-case bone, it is certainly not in the many skulls I have examined, but is homologuous to the squamosum of the Stegocephalia and Ichthyosauria is shown by *Saphœosaurus* which bridges over *Sphenodon* with *Ichthyosaurus*. In regard to the homologies and nomenclature given in my paper in the Anat. Anz. I have not to change a single point.

2. *The systematic Position of the Mosasauridæ.*

"Like Owen, Marsh and Dotto, he [Baur] does not perceive that this group (Mosasauridæ) is essentially distinct from the Latertilia, and concludes with them that I have erred in alleging it to present affinities to the Ophidia." Cope, p. 857.

In order to determine this matter, Prof. Cope, thinks it necessary to know, what the characters are that distinguish snakes from Lizards. The first character, the descending of the parietal and frontal bones to the basicranial as is in the Ophidia is as he admits himself, not constant, being found also in the Amphisbænians and Anniella.[7]

As a second character he mentions, that the prosquamosal (supratemporal) is present in the Lacertilia, but absent in the Ophidia, stat-

[6] Spix J. Baptista, Cephalogenesis, sive capitis ossei structura. gr. fol. Monachii, 1815.

[7] I may mention here the interesting fact that in some Amphisbænians, the parietals and frontals are connected by a especial element with the basisphenoid, in other genera they unite with this element. The basisphenoid of snakes is also a composite of this bone and the basisphenoid proper.

ing the Amphisbænians and Anniellidæ to be exceptions; but the Geckonidæ and Uroplatidæ also lack the prosquamosal. Therefore, this character does not hold.

A third distinction according to Prof. Cope is that the quadrate bone is supported by the paroccipital [squamosum] in the snakes, and the exoccipital [paroccipital] in the Lizards. In the Mosasauridæ the squamosal (paroccipital) is said to be more largely developed than in the Lacertilia, and that it supports the quadrate bone as in the Ophidia.

This is by no means correct. It is the squamosal (paroccipital, Cope) which supports the quadrate in most of the Lacertilia; in some forms only, the paroccipital (exoccipital, Cope) takes part (Chamæleon). But in many Lizards, the Iguanidæ for instance, the paroccipital processes do not support the quadrate at all. This character, therefore, falls to the ground. I can not see any principal difference in the relation of the squamosal (paroccipital, Cope), the paroccipital (exoccipital, Cope) and quadrate in the Mosasaurs and the Iguanidæ. In the squamosal (paroccipital, Cope) of *Platecarpus* (fig. 20, 21, Pl. II) of my paper we can distinguish 3 portions: first, an upper one, which joins the parietal processes; second, an inner one which is suturally united with the paroccipital and petrosal, and a lower one, which supports the quadrate.

In a skull of *Conolophus* (Iguanidæ) before me, I find very similar conditions, the inner process only is not so much developed, but it reaches the petrosal. The differences enumerated by Prof. Cope between the Lacertilia and Mosasauridæ do not exist; and I can not discover one trace of a character of the snakes. The phlogenetic conclusions of Prof. Cope are not supported by the facts. I believe as firmly as formerly, that the Mosasauridæ are true Lacertilia adapted to aquatic life; and that their closest living representatives are the Varanidæ. The Varanidæ have retained the terrestrial limbs, and the free nasal bones but have lost the postorbital bar. The Mosasauridæ have required fins with digits[8] with numerous phalanges, the nasals have become united with the premaxillaries, but the postorbital arch has been retained.

[8] In a specimens of *Thorosaurus*, which I have lately examined through the kindness of my friend, Prof. S. W. Williston, Lawrence Kas. I find in the forelimb the following number of phalanges.

1st. digit 5 (+3); probably 8, the 5 proximal ones are preserved.
2nd. digit 7 (+2); probably 9, the 7 proximal ones are preserved.
3rd. digit 9 (+1); probably 10, the 9 proximal ones are preserved.
5th. digit 10 (+1); probably 11, the 10 proximal ones are preserved.
5th. digit 11 or 12; all preserved, but some covered up.

Reply to Dr. Baur's critique on my paper on the Paroccipital bone of the Scaled Reptiles and the Systematic Position of the Pythonomorpha.—In the following pages I continue the discussion of the questions raised by Dr. Baur in his papers.

I. The Paroccipital of the Squamata.

Dr. Baur in the paper just preceding reiterates the opinion that the parotic process of the exoccipital bone of the scaled reptiles includes the paroccipital element, and that I have fallen into a serious error in supposing that his squamosal is the true paroccipital. He cites various authorities against me and intimates that I am not familiar with the literature, which he says is accessible. In this last statement he is undoubtedly correct, as the greater part of it is in my private library.

I must call my critic's attention at the outset to the fact that my last paper has reference to the elements which support the quadrate bone, and not to the presence or absence of the opisthotic element of Huxley. It was not necessary, therefore, to enter into an exposition of the evidence for the existence of the latter which, as he says, has been proven by Siebenrock and Leydig in the lizards, Rathke in the snakes, and himself and Siebenrock in the Rhynchocephalia. It is the element which supports the quadrate bone for which the name paroccipital (Owen) is appropriate, while the element which includes the posterior semicircular canal is the opisthotic of Huxley.

Baur asserts that the so-called parotic process of the exoccipital which supports the quadrate in the Squamata is the same element as that termed opisthotic by Huxley. This I deny, and believe that in this it is Baur and not myself who has fallen into error. Siebenrock instead of asserting this to be the case, denies it in the following language:[9] "It is not the processus paroticus of the pleuroccipital (exoccipital) which is homologous with the (paroccipital Owen) opisthotic Huxley, but the portion anterior to the foramen nervi-hypoglossi superius which protects the organ of hearing." Siebenrock here uses the names of Owen and Huxley as referring to the same element, but he makes the clear distinction, which is the important point, between the parotic process of the exoccipital and the element which contains the posterior semicircular canal. What then is the element which articulates with the quadrate in the different orders of the Reptilia?

In the Testudinata, and, according to Baur, in Sphenodon,[10] the

[9] Sitzungsber. Wiener Akademie, 1894, p. 285; On the Skeleton of *Lacerta simonyi*.

[10] Siebenrock, Sitzungsberichte Wiener Akad. Wiss, 1893, p. 254.

element which extends externally from the exoccipital to the quadrate is continuous with the opisthotic, but the semicircular canal is included in its proximal part only. Here the structure is entirely different from that which characterizes the Squamata, where the opisthotic does not extend distad of the canal and fuses early with the exoccipital. This character is to be added to those which distinguish the Rhynchocephalia from the Squamata. The paper which Dr. Baur criticizes above had reference to the Squamata, and the question at issue is what is the element attached to the end of the parotic process of the exoccipital in this order, which I call paroccipital, and which Dr. Baur calls squamosal. That it is not the opisthotic is clear enough.

The reasons for supposing that the element which I call paroccipital in the Squamata is really such, are as follows. In the orders Testudinata and Rhynchocephalia, where a continuous element extends from the posterior semicircular canal to the quadrate, this so-called paroccipital is not distinct. In the Squamata, where the opisthotic is restricted to the region of the canal and does not reach the quadrate, this so-called paroccipital is distinct. It becomes then probable that the paroccipital of the Squamata is represented by the distal, non auditory part of the element whose auditory portion is the opisthotic of the Testudinata and Rhynchocephalia. This hypothesis is confirmed by the structure in the Pythonomorpha, which is intermediate between that of the two types mentioned. The paroccipital extends proximad to the position of the opisthotic and petrosal, which it does not do in the Lacertilia or the Ophidia.[11]

Neither Owen nor Huxley distinguished the single element of the Testudinata as composed of two. The name paroccipital is the prior, and I have retained it for the distal or quadrate portion, while Huxley's name of opisthotic belongs to the auditory portion for which he designed it. The direct evidence for such a primitive division of this element in the Testudinata has, however, yet to be produced, and I am entirely willing to give up the view above defended should it turn out on further investigation to be untenable.

II. The Affinities of the Pythonomorpha.

No one who has examined carefully the relations of the paroccipital to the surrounding proximal elements in this suborder and compared them with their relations in the Lacertilia, can fail to see the important difference between the two. My opportunities of studying

[11] See Transac. Amer. Philos. Soc., 1892, p. 19, where the structure in Mosasaurus is represented in fig. 3.

these characters have been good, including the principal collections of European Museums and those of this country. I have at hand crania of all but one or two of the North American genera of Lacertilia, and the principal ones of all other countries, and I maintain that the difference between them and the Pythonomorpha is universal. I maintain, contrary to Dr. Baur's statement, that in all Lacertilia the exoccipital supports the quadrate, and that in the Pythonomorpha and the Ophidia the exoccipital does not support it or generally touch it. I also maintain that the paroccipital (squamosal Baur) does support the quadrate in the Ophidia, while it is only in contact with a very small part of it in the Lacertilia. This assertion is true of the Iguanidae as well as of all other Lacertilia. Of this family I have many crania. These do not include Conolophus, to which Dr. Baur refers, but I have the nearly allied genus Cyclura, which has the character of other Lacertilia in this respect. Steindachner's figures of Conolophus show that it closely resembles Cyclura in the point in question, and I have no doubt that if Dr. Baur will take to pieces the proximal articulation of the quadrate of Conolophus as I have done in Cyclura, he will find an articular facet on the exoccipital and none on the paroccipital (squamosal). In fact the quadrate extremity of the paroccipital in Lacertilia is so insignificant, and the proximal end of the quadrate is so considerable, that the support of the latter by the former is a mechanical impossibility. Since the articulation of the quadrate in Pythonomorpha, of which I have seen all the American genera, is exclusively with the paroccipital, it is clear that the distal as well as the proximal relations of that element are different from those of the Lacertilia. On the other hand the relations to the quadrate are the same in the Pythonomorpha as in the snakes, and the proximal articular characters are approached by the Tortricid snakes more nearly than by any lizard. In the distal articulation of the paroccipital with the supratemporal, the Pythonomorpha and lizards agree, as was long since pointed out by authors.—E. D. Cope.

Recent Elevation of New England.[12]—I submitted some conclusions to the American Association for the Advancement of Science in advance of the preparation of a detailed paper upon this subject. Indeed in a discussion of a paper by Prof. C. H. Hitchcock before the Baltimore meeting of the Geological Society of America (December 1894) the present writer called attention for the first time to certain terrace phenomena which might be used as a yard stick in

[12] Read by J. W. Spencer at the Springfield meeting of the Am. Ass. Adv. Sci.

measuring recent terrestrial elevations. Since that meeting I have gone over many critical localities and the phenomena confirm the conclusions then announced. The importance of this contribution is not so much in a determination of the magnitude of post-glacial elevation as in finding a means of physical measurement of it and in my consequent challenge of the doctrine of ice dams in the late formation of high-level beaches and terraces. For no apparent reason has the structure of the terraces escaped early observation to such a degree that hitherto it has not been described in such a way as to be used as a meter of recent terrestrial changes of level.

The structure may be briefly set forth. The terraces are not those of the sloping rivers, but are the much more horizontal remains of water plains. The platforms do not merge from one step to the next below and thus make the ancient slopes of the rivers as has been often assumed, but they abruptly descend as steps to the lower plains. Thus a small meadow widens out into a broad flat, with the river near the surface of the plain along the upper part of the flat, but further down, it descends to greater depths below the same floor or plain, which on being eroded become a lateral terrace bounding the still lower plains. Thus as meadows, plains and remanie terraces, the same platforms may often be traced for many miles in length, disappearing owing to erosion, and to the distance of the terraces from the source of supply of sands and gravels. The terraces often cross the country and extend from one valley to another. Subject to certain corrections, these meadows, flats, and terraces mark the lowering of the base planes of erosion, or in other words indicate the elevation of the land. That is to say, the land has approximately been elevated as much as the sum of the heights of the terrace-plains one above the other. In some places, these are situated only a few feet apart in elevation, yet in other localities several of the steps are so combined that the great terraces may be from 50 to 250 feet above the river. Occasionally, in the course of a few miles, scores of terraces, may be ascended or descended and counted with certainty. Yet at any one locality, there are seldom more than four or five lateral terraces distinguishable; but these four or five are not identical with the four or five platforms observed several miles away, in the same great valleys.

Such distinct terraces are seen to an elevation of 2700 feet at the base of Mount Washington, with terrace material much higher, but without the preservation of the structure upon the steep mountain slopes. The terrace forms described have now been observed under so many

conditions and over such a wide extent of territory that they appear to be the prevailing conditions and not exceptional.

Did these accumulations in the great valleys, often two miles or more in width, occur only on the northern and western sides of the high lands the theory of glacial drains might be supported. But they also occur on the southern and eastern sides of so many mountain masses so as to preclude the idea of their formation in glacial lakes. And the author has found the same structure within a few degrees of of the equator.

The platforms are commonly cut out of till deposits filling preglacial valleys, and are covered with sands and gravels. From these evidences, the author concludes that the New England Mountain regions have been elevated at least 2700 feet in the post-glacial epoch, or in other words the post-glacial submergence was at least 2700 feet in New England, but much less farther westward. Although this great continental movement has so recently occurred, yet the magnitude of the coastal changes have not yet been fully considered, but it was probably much less.—J. W. SPENCER.

BOTANY.[1]

Sacaline.—Under this name a species of *Polygonum* (*P. sachalinense* F. Schmidt, from Saghalin Island) has been freely advertised in this country within the last six months as a forage plant, especially adapted to the conditions which prevail upon the Great Plains. Extravagant claims as to its great value were made by dealers who wished to supply the farmers with roots or seeds. It was said that from one hundred to nearly two hundred tons of the plant could be grown upon an acre, and the forage yielded by it was said to nearly or quite equal that of Alfalfa or Red Clover in nutritiousness.

For two years the writer has watched carefully a clump of this plant growing upon a favorable spot upon the campus of the University of Nebraska. In spite of the fact that the plants have had better care than they would have in an ordinary field, they have made but a moderate growth, at no time exceeding three feet in height. The clump is moderately ornamental, about as much so as a fine growth of dock (*Rumex*), and less so than rhubarb (*Rheum*). The foliage is neither dense nor abundant, while the stems and branches are very

[1] Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.